ClearVote 1.0
Test and Verification Specification

This document describes the testing specifications for ClearVote.
ClearVote Test and Verification Specification

Part number: 100067-10001

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Document History

<table>
<thead>
<tr>
<th>Date</th>
<th>Author</th>
<th>Description</th>
<th>Version</th>
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<tbody>
<tr>
<td>8/10/2015</td>
<td>Deborah Block-Schwenk</td>
<td>ClearVote Version</td>
<td>1.0</td>
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Contents

Contents .................................................................................................................................................................. 3

1  1.0 Introduction ............................................................................................................................................... 5
   1.1 Intended Audience and Use ................................................................................................................ 5
   1.2 Terminology ......................................................................................................................................... 5

2. Testing Process ................................................................................................................................................... 5
   2.1 History ........................................................................................................................................................... 5
       2.1.1 ClearAudit as a baseline ........................................................................................................................ 5
       2.1.2 ClearAudit and ClearCount .................................................................................................................... 6
       2.1.4 Certification requirements ...................................................................................................................... 6
   2.2 Test Case Development Process .................................................................................................................. 6
       2.2.1 New builds and build acceptance tests .................................................................................................. 6
       2.2.2 Evolution of test cases ........................................................................................................................... 7

3. Test Environment ................................................................................................................................................. 7

4 Test Data ............................................................................................................................................................... 9
   4.1 Sources of Test Data ..................................................................................................................................... 9
   4.2 Determining which data to use .................................................................................................................... 10

5. Test Artifacts .................................................................................................................................................... 10
   5.1 Test Plans .................................................................................................................................................... 10
   5.2 Test Cases ................................................................................................................................................... 10
   5.3 Tickets .......................................................................................................................................................... 11

6 National Certification Considerations ................................................................................................................. 12
   6.1 Acceptance criteria ...................................................................................................................................... 12
   6.2 Processing accuracy .................................................................................................................................... 12
       6.3 Control and data input/output for ClearDesign and ClearAccess ......................................................... 12
       6.4 Control and data input/output for ClearCount ......................................................................................... 13
       6.5 ClearCount Data quality assessment and maintenance ........................................................................ 13
           6.5.1 ClearCount Ballot interpretation logic .................................................................................................. 13
       6.6 Exception handling .................................................................................................................................. 14
       6.7 Security ....................................................................................................................................................... 14
       6.8 Production of audit trails and statistical data ............................................................................................... 14
1 1.0 Introduction

This document describes the testing specifications for the ClearVote system. Testing is an essential part of the Quality Program designed by Clear Ballot Group (CBG) to ensure that the ClearVote system's components for ballot design, tabulation, accessible voting sessions, and results reporting meet or exceed all requirements.

See the Election Preparation Guides and Administrators Guides for each component of the ClearVote system (ClearDesign, ClearCount, ClearAccess) for setup instructions and descriptions of components.

1.1 Intended Audience and Use

The Clear Ballot Group Quality Assurance (QA) and development staff have compiled this document as a high-level guide for current and future QA testing efforts for the ClearVote product and related Clear Ballot Group products. Other Clear Ballot staff can use this document to familiarize themselves with the testing process for discussions with election officials, assisting with the testing process, or for general knowledge.

It corresponds to the 2005 Voluntary Voting System Guidelines (VVSG) Volume 2 Section 2.7.

1.2 Terminology

It is assumed that the reader of this document is familiar with general election terms as well as general quality assurance terms. ClearVote terms are defined elsewhere in the TDP.

2. Testing Process

This section describes the history and steps involved in developing the testing process at Clear Ballot.

2.1 History

2.1.1 ClearAudit as a baseline

Prior to the development of the ClearCount system, the Clear Ballot Group produced the ClearAudit product. As its name suggests, ClearAudit tabulates ballots and compares the results to the comparison system to provide an independent audit of election results.

ClearAudit contains the same Tabulator, UI administrative functions, and reports as ClearCount. (ClearAudit contains additional reports and utilizes scoring algorithms for comparing the ClearAudit results with those of the comparison system.)

ClearAudit functionality had been tested primarily through ad hoc testing by Clear Ballot Group staff. In preparation for demonstrations and pilot projects in Florida and Colorado, testing was focused on accuracy, integrity, and correct visualization of results (i.e., reporting and vote visualization). The product was demoed multiple times, especially in Florida and Colorado, and used in pilot projects in both states.

Feedback from the demonstrations and pilot projects was used to create additional requirements for UI reports, export formats, and the interpretation of marginal votes (determined by the Discriminant Function; see the ClearCount System Functionality Description for more information.) These requirements were traced through tickets entered in Clear Ballot’s Trac system, described in more detail later in this document.
2.1.2 ClearAudit and ClearCount

As stated above, ClearCount and ClearAudit share the same code base. The additional reports applicable in the ClearAudit system become part of the UI when the comparison voting results are uploaded to the system or when the tables containing the comparison data are included in the Ballot Definition File (BDF) for the ClearAudit election. In other words, the code is also present in the ClearCount system, it is simply not utilized.

For that reason, all tickets and requirements for ClearAudit were included in the ClearCount system, with the exception that anything referring to the comparison system or the ballot discrepancy analysis was excluded.

2.1.3 ClearDesign and ClearAccess

The ClearDesign Election Management System and ClearAccess Accessible Ballot Marking Device were added to ClearCount in order to create the full end-to-end ClearVote System in 2015. With ClearVote, jurisdictions can manage their election information, layout their ballots and create PDFs for printing, provide a voting solution for those who need an accessible voting solution, tabulate their ballots and report on their results.

2.1.4 Certification requirements

ClearVote was submitted in 2015 for Certification in the State of Colorado, following the VVSG 1.0.

2.2 Test Case Development Process

Clear Ballot Group utilizes the Trac bug tracking system for bugs, requirements and new feature requests.

Test cases are developed by reviewing the Trac tickets, along with ClearVote user documentation. If there are questions about the correct functionality, meetings are called to discuss the requirements with the development staff. Both test strategies and test cases are discussed during these meetings.

One such meeting on ClearCount led to the creation of a suite of test case reports to cover all functional areas of the ClearCount system. As the initial test case reports were written and additional discussions were initiated, more test case areas were added.

Weekly ClearDesign team meetings beginning in late 2014 provided an additional source of information on that product which was converted to test cases and Trac tickets as appropriate. ClearAccess information was added to the ClearDesign meeting since those two products are closely linked.

Completed test case reports are stored in Mercurial, Clear Ballot Group’s source control repository, and are available for peer review. Working copies of test case reports may also be stored in a company specific Google drive for collaboration and peer review. A formal peer review process for test case reports is not yet in place.

The test approach and related information for different components or functional areas of the ClearVote system are documented separately in Test Plan documents.

2.2.1 New builds and build acceptance tests

Mercurial is used to keep track of new versions of software and the exact changes it includes. Abbreviated release notes are also published on an internal blog. As documented in our ClearVote Quality Assurance Program, QA is notified when a new build has been installed.

Regression tests are run on the new build. Upon successful completion of the acceptance tests, the build is accepted for general testing. If the acceptance test fails, the new build is rejected. New defect
tracking tickets are written as applicable and the build is returned to development for additional work.

The scope of general testing for a specific build is determined initially by the contents of the changes. For example, a ClearCount build with only UI changes doesn’t require Tabulator testing beyond the most basic regression test. Changes that involve tabulation are tested more extensively. ClearDesign ballots are tested in ClearCount (end-to-end testing) with every major new ClearDesign build.

Once the new build has been accepted, the test cases that have been identified are performed. The list of test cases performed is noted by QA. Component-specific tests are run before end-to-end tests. Performance tests, when applicable, are run after end-to-end tests. Test case runs and results are noted on the test case document (see more on test case documents below), along with defect numbers. New defects are entered into the Trac system (see more on defects, below). The version/build Id is included in the ticket description.

After completion of testing, defects that were fixed with the release are closed and noted as verified. Defects that were not fixed are reassigned back to development with updated comments.

2.2.2 Evolution of test cases

New tests are added to test case reports based on the tickets that have been verified.

Test case reports are periodically reviewed by the development staff, the CTO or the Director of Product Management to verify that they cover all aspects of requirements.

3. Test Environment

ClearVote testing is performed using COTS models of laptops and scanners as specified in the ClearVote Approved Parts List. As test case reports are executed, the software and hardware configuration is filled out, including the scanner and laptop model (except for browser-based UI reports, which require only browser name and version).

For system tests, the standard configuration is detailed in Figure 1 below. The ClearVote Approved Parts List has more details.

<table>
<thead>
<tr>
<th>Physical component</th>
<th>Hardware</th>
<th>Software</th>
<th>Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>ClearCount: ScanServer computer</td>
<td>Windows laptop. Recommended models: • Hewlett-Packard HP ProBook 4540s • Toshiba Satellite L855 • Hewlett-Packard HP Envy 17</td>
<td>ClearCount installs: Ubuntu Linux CIFS MySQL Apache Web Server ClearCount web server</td>
<td>Ethernet connection to router or to ScanStation Wireless disabled</td>
</tr>
<tr>
<td>ClearCount: ScanStation</td>
<td>Windows laptop. Recommended</td>
<td>Windows 7 or 8 ScandAll PRO (Fujitsu scanner)</td>
<td>USB connection to scanner. Ethernet connection</td>
</tr>
<tr>
<td>Computer</td>
<td>Models</td>
<td>Software</td>
<td>To Router or to ScanServer</td>
</tr>
<tr>
<td>-------------------</td>
<td>------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------</td>
<td>-----------------------------------------</td>
</tr>
<tr>
<td>Toshiba Satellite L855</td>
<td>• Hewlett-Packard HP ProBook 4540s&lt;br&gt;• Toshiba Satellite L55 / S55 / S55t</td>
<td>TWAIN driver (Fujitsu scanner software)&lt;br&gt;ClearCount Tabulator&lt;br&gt;ClearCount update scripts and DeleteBox utility</td>
<td>Wireless disabled.</td>
</tr>
<tr>
<td>Fujitsu fi-7180</td>
<td>Fujitsu fi-6670&lt;br&gt;Fujitsu fi-6800</td>
<td>(installed on ScanStation, see above)</td>
<td>USB connection to ScanStation</td>
</tr>
<tr>
<td>ClearCount, ClearDesign: Switch/Router</td>
<td>Gigabit router, minimum of 4 ports</td>
<td>(N/A, router configuration utility as applicable)</td>
<td>ClearCount: ScanServer, ScanStation(s) and Election Administration Station(s) connect through the router.&lt;br&gt;No internet connection.&lt;br&gt;ClearDesign: Design Server and Design Station connect through the router. No internet connection.</td>
</tr>
<tr>
<td>Windows laptop. Recommended models: HP ProBook 4540s&lt;br&gt;Toshiba Satellite L855</td>
<td>Windows 7 or 8 Browser: Internet Explorer, Firefox or Chrome.</td>
<td>Ethernet connection to Design Station or switch/router</td>
<td>Wireless disabled</td>
</tr>
<tr>
<td>Windows 8.1 Laptop.</td>
<td>Clear Design installs:&lt;br&gt;Linux&lt;br&gt;Apache MySQL&lt;br&gt;And additional related components. See Clear Design specifications for more details</td>
<td>Ethernet connection to Design Station or router.</td>
<td>Clear Design: Design Server</td>
</tr>
<tr>
<td>Windows 8. Browser: Internet Explorer, Firefox or</td>
<td>ClearDesign: Design Station</td>
<td>Ethernet connection to Design Server or switch/router</td>
<td>Windows 8. Recommended Models:</td>
</tr>
</tbody>
</table>
Table 1: Standard configurations for functional testing

For ClearCount tests that involve re-tabulation of previously scanned images, the configuration is as above, except the scanner is not used. The Tabulator runs on the ScanStation laptop, processing the images as if they had been placed there by a scanner.

For end-to-end testing, ClearDesign-created ballots are then printed and used with the ClearCount configuration. ClearAccess-generated ballots are also used with the ClearCount configuration.

For ClearCount performance testing, a larger number of ScanStations are used. The test case report will indicate how many COTS laptops are used as ScanStations for a given test and which model(s) are used. In this configuration, all ScanStations are connected to a single ScanServer pointed to a single active election. An Ethernet router or switch is used when there are many ScanStations.

4 Test Data

4.1 Sources of Test Data

All test case reports must specify the origin of the test data from one of the following sources:

- Marked paper ballots created on ClearDesign and hand- or auto-marked.
- Marked paper ballots created by the ClearAccess Ballot Marking device
- Marked paper ballots from elections provided by election officials
- Paper ballots marked by hand by Clear Ballot Staff
- Blank Paper ballots
- Paper ballots with data generated by an Automated Ballot Marking tool
4.2 Determining which data to use

For ClearDesign, a mix of manually created data and data imports in all supported formats are used to test all aspects of the system. Imports may be actual data files obtained from jurisdictions or test data files created to verify certain aspects of the system. The variety of data is used to cover as many scenarios as possible.

For ClearCount, paper ballots (marked and/or blank) are used in full system or integration tests. Test decks marked by Clear Ballot Staff are used to test specific test cases that might not be common or easily identified in sets of ballots containing actual election results. Ballots created from ClearDesign are used as often as possible in system tests.

Using images of previously scanned ballots allows Clear Ballot Group QA staff to compare software tabulation results with known results from ballots used previously. Performance testing using pre-scanned ballots can be performed more quickly and with fewer human resources than manually scanning ballots.

Ballots produced by an Automated Ballot Marking Tool are useful in creating specialized test decks more quickly and accurately than when created manually.

ClearAccess data is the ADF file created by ClearDesign. Various elections are created to test ADF variations and specific election properties.

5. Test Artifacts

This section describes the different test artifacts produced by the Clear Ballot QA team.

5.1 Test Plans

ClearDesign and ClearAccess each have a single accompanying test plan. For ClearCount, each major area of testing has an accompanying test plan. The test plan describes the specific approach to testing for that area, including

- Features to be tested
- Features not to be tested
- Test Approach (test strategy)
- Test environment when different from the standard described in this document (environment information is also provided in the test case report).
- General information on data used (specifics are described in the test case report).

Test plans in excess of those submitted with this document can be supplied upon request.

5.2 Test Cases

Each test case report document describes a specific set of functions that are tested to verify the correct behavior.

Test cases include:

- Instructions where applicable
- Prerequisites
- Test Conditions
• Test Name
• Test Objective
• Date executed
• Tester
• Feature/Functionality
• Test Description (test step)
• Expected Result
• Actual Result
• Pass/Fail
• Status/Ticket # (Defect identification based on actual results)
• Test data, including source of data and details of data content

5.3 Tickets

Trac is used for documenting defects in Clear Ballot products. Trac is an open-source enhanced wiki and issue tracking system maintained by Edgewall Software (http://trac.edgewall.org/).

Trac tickets are created for defects, enhancements, and tasks. The ticket description includes information on what election data was used, what version of the software was tested, what URLs are relevant (for reports), what HW/SW configuration was used, and other relevant information.

Required fields are
• Summary
• Reporter (defaults to user)
• Description
• Type (drop-down list: defect, enhancement, task)
• Priority (drop-down list: time-critical, high, normal, low, very low)
• Component (drop-down list: ballotmapper, database, evs, installer, pdfminer, PDFtoXML, Tabulator, TWAIN, vsess, webapps)
• Owner (defaults to the developer in charge of the component).

Optional fields are:
• Milestone
• Keywords
• Estimated Number of Hours (defaults to 0)
• CC
• Add hours to ticket (defaults to 0)
• Billable (checkbox, defaults to checked)

Notifications of changes in status are not sent via messaging. The Trac timeline feature displays all changes in status to tickets. QA and development staff review the timeline to review status changes in tickets. Trac reports show each ticket by milestone and staff also review that report every day. (Email and Skype messages are used to inform developers of time-critical and high priority tickets). Tickets that developers believe have been fixed are sent to QA for verification and closure.
6 National Certification Considerations

The Clear Ballot Group is not submitting the ClearVote system for National Certification. However, Clear Ballot Group is incorporating portions of the Voluntary Voting System Standards 2005 into its processes.

The QA processes of the Clear Ballot Group are designed to validate that the design of the ClearVote system is suitable for a voting system with central count tabulation.

6.1 Acceptance criteria

Using information gathered from numerous discussions with election officials, real world experience and the VVSG, Clear Ballot engineers built ClearVote with a set of functions to meet the needs of election officials in a wide variety of jurisdictions. Acceptance tests are run to validate the presence of the required functions and to verify that the functions perform as required so that the complete system will meet election officials’ needs as a central count system.

These validation and verification procedures were incorporated into the ClearVote system's functional, accuracy, data quality, ballot interpretation, exception handling, security, and reporting and audit trail testing.

6.2 Processing accuracy

ClearDesign is used to create ballots for tabulation.

ClearVote has been designed to meet or exceed standards for accuracy while using easily obtainable, easily scalable COTS hardware. Extensive system and performance testing with large numbers of ballots or ballot images are used to verify that ClearCount produces accurate results.

System tests involving paper ballots and the re-tabulation of previously tabulated elections provide methods to validate the accuracy of the ClearCount system and the Tabulator.

Accuracy is verified by:

- Linking paper ballots to electronic images
- Comparing electronic ballot images with the Tabulator’s ballot annotations
- Comparing the ballot, choice, and contest results to reports that identify ballots cast, vote counts, and precinct and box totals.
- Comparing cross-endorsed contest results to party results as defined by New York State.
- Reviewing audit logs to identify the events that occurred.

ClearAccess ballots are also tested for tabulation accuracy by ClearCount.

6.3 Control and data input/output for ClearDesign and ClearAccess

The ClearDesign system inputs various data import files including GEMS imports, Oregon OCVR files, and ClearCount BDFs. Correct import is verified through review of imported data and, after needed correction review of output. Outputs are BDFs, PDFs, and ADFs.

BDFs are verified through use in ClearCount for end-to-end testing. PDFs are used to print the ballots used in those tests. ADFs are verified in ClearAccess, with the printed ballots also being tabulated by ClearCount.
6.4 Control and data input/output for ClearCount

The ClearCount system inputs paper ballot vote data in a controlled central count setting and then outputs vote count reports and audit logs. The functional testing performed by the Clear Ballot Group will incorporate the central count requirements for paper-based system processing and reporting; this validates that ClearCount provides methods to control access and review input and output data.

Controls and inputs/outputs are verified through tests including:

- User access tests
- Separation of roles between ScanStation operator and Election Administration roles (see the ClearCount Security Specification for more)
- Use of target cards and verification via the Box Report and filtering by box on other UI reports such as the Statement of Votes Cast report
- Functional and system tests that verify results compared to known previously tabulated elections. Test data is specified for each test case report.
- Logging of all events (see below).

6.5 ClearCount Data quality assessment and maintenance

Since the ClearCount product of the Clear Ballot Group can be used as an audit platform or a central count system, it is designed to assess and compare data and data quality whether tabulated directly or imported. ClearDesign-created ballots and ClearAccess-marked ballots are ultimately assessed in the ClearCount system.

Verification processes make use of this flexibility by re-tabulating stored images and confirming that the data retains its quality and gives the identical result compared to the previous tabulation. This verification is a component of performance testing and UI testing as well as installation testing.

System tests validate the data quality by comparing the test deck values with the UI reports. Tabulator tests use a similar methodology but focus on the Tabulator component.

Comparison of UI reports and the values in the exported Statement of Votes Cast with the UI reports confirm that the data is consistent and correct across the system. All tests are performed with known data sets and results are checked for correctness.

6.5.1 ClearCount Ballot interpretation logic

Clear Count’s Tabulator not only accurately determines the vote target but also provides a visual mechanism for election officials to view marginal votes on the screen and within the context of the entire ballot image.

Tests include:

- Tabulator tests: does it function correctly, read the correct number of ballots, and identify unreadable ballots?
- UI report review: does it validate that vote totals are correct, under votes and over votes are interpreted correctly, and marginal marks are displayed?
- Ballot adjudication and resolution: does it validate that ballots that require manual intervention are identified, changes are recorded, and vote totals are adjusted correctly?
- System tests: does it verify that the end-to-end process from scanning paper ballots to reviewing of UI report results is correct?
6.6 Exception handling

The Clear Count system scans paper (optical scan) ballots, leaving the ballot undamaged for reference by election officials or for re-scanning if there is a problem with the scanner or Tabulator. To verify that the system recovers as designed, QA runs a full suite of exception handling test cases as well as system-wide test cases that include physical errors such as network and power disconnections, configuration errors, scanner jams, and unauthorized access attempts.

ClearDesign exception handling tests include invalid manual input, invalid import formats, attempts to access unauthorized functions, user login credentials and network/power loss.

ClearAccess exception handling tests include printer issues (loss of connection, printer jam), incorrect access codes and proper triggering of errors and warning messages (for example undervote warning messages or printer error messages).

6.7 Security

ClearCount security is provided by a combination of user access levels, wired networking, and documented security processes that effectively prevent tampering with election results and prevents access to critical functions by all but authorized personnel. As a central count system, some security measures used for precinct count systems are not applicable. The jurisdiction is responsible for the physical security of the equipment. Test cases and auditing of security procedures will validate that the Clear-Count system provides a secure central count voting solution. (See the ClearCount System Security Specification and the ClearCount Election Administrator's Guide.)

Tests that verify the security procedures work correctly are included in the test case reports for installation and hardening and user and election access. Logging and error handling tests also include some security aspects.

ClearDesign security is provided by a combination of secure passwords, user access levels that provide granular permissions and wired networking. Design stations can be further strengthened using Windows security settings.

ClearAccess security is provided by passwords and access codes, Windows security settings, no internet access and physical security including tamper evident seals. See the ClearAccess Installation and Preparation Guide for more details.

6.8 Production of audit trails and statistical data

The ClearCount system contains two logs. The Web Activity Log includes login, user administration, and election administration information. The Election Activity Log includes election-specific log events such as tabulation and the use of the DeleteBox program.

QA will validate that all applicable events produce log entries and will verify the entries are correct and understandable.

ClearDesign has a System Log and election specific logs. The System Log contains information such as user login or logout, system timeout and election creation or deletion.

ClearAccess also has a system log and election specific logs. The System log contains login and status information while the Election log notes when ballots are voted and printed among other events.